

Spring Boot REST API Security Overview



You will learn how to ...

- Secure Spring Boot REST APIs
- Define users and roles
- Protect URLs based on role
- Store users, passwords and roles in DB (plain-text -> encrypted)

Practical Results

- Cover the most common Spring Security tasks that you will need on daily projects
- Not an A to Z reference ... for that you can see **Spring Security Reference Manual**

<http://www.luv2code.com/spring-security-reference-manual>

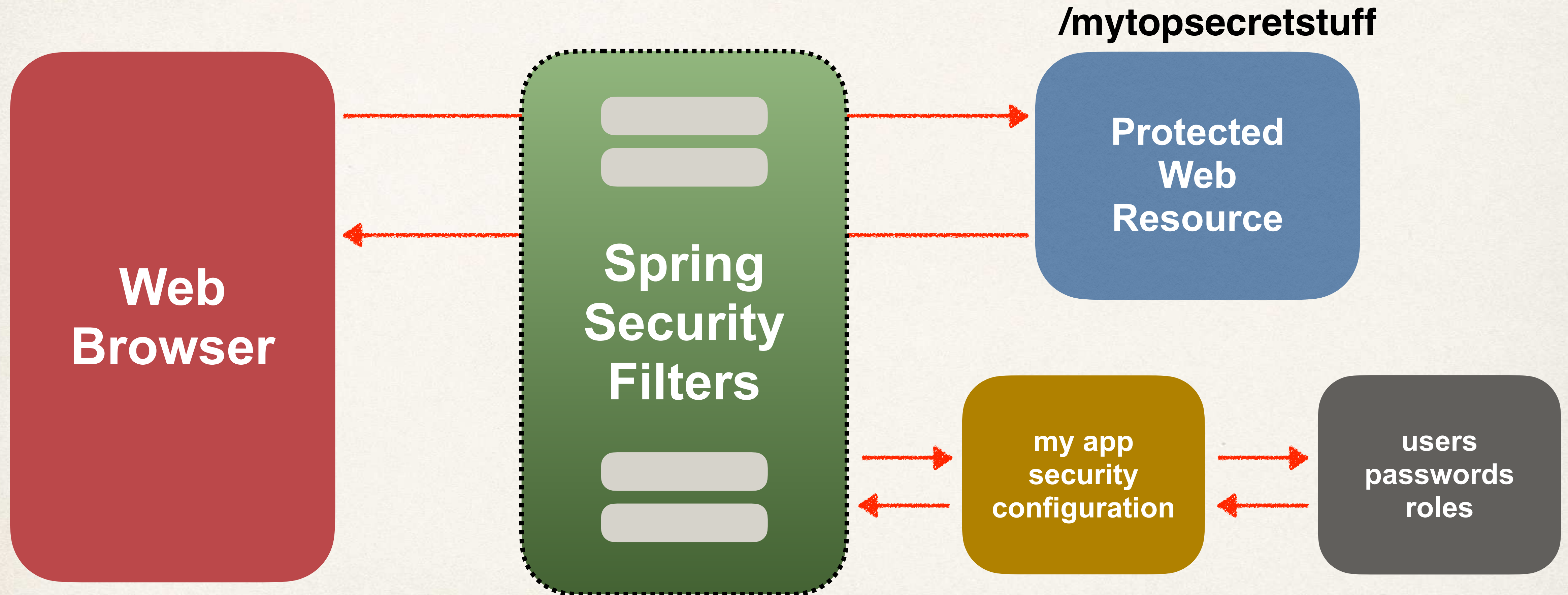
Spring Security Model

- Spring Security defines a framework for security
- Implemented using Servlet filters in the background
- Two methods of securing an app: declarative and programmatic

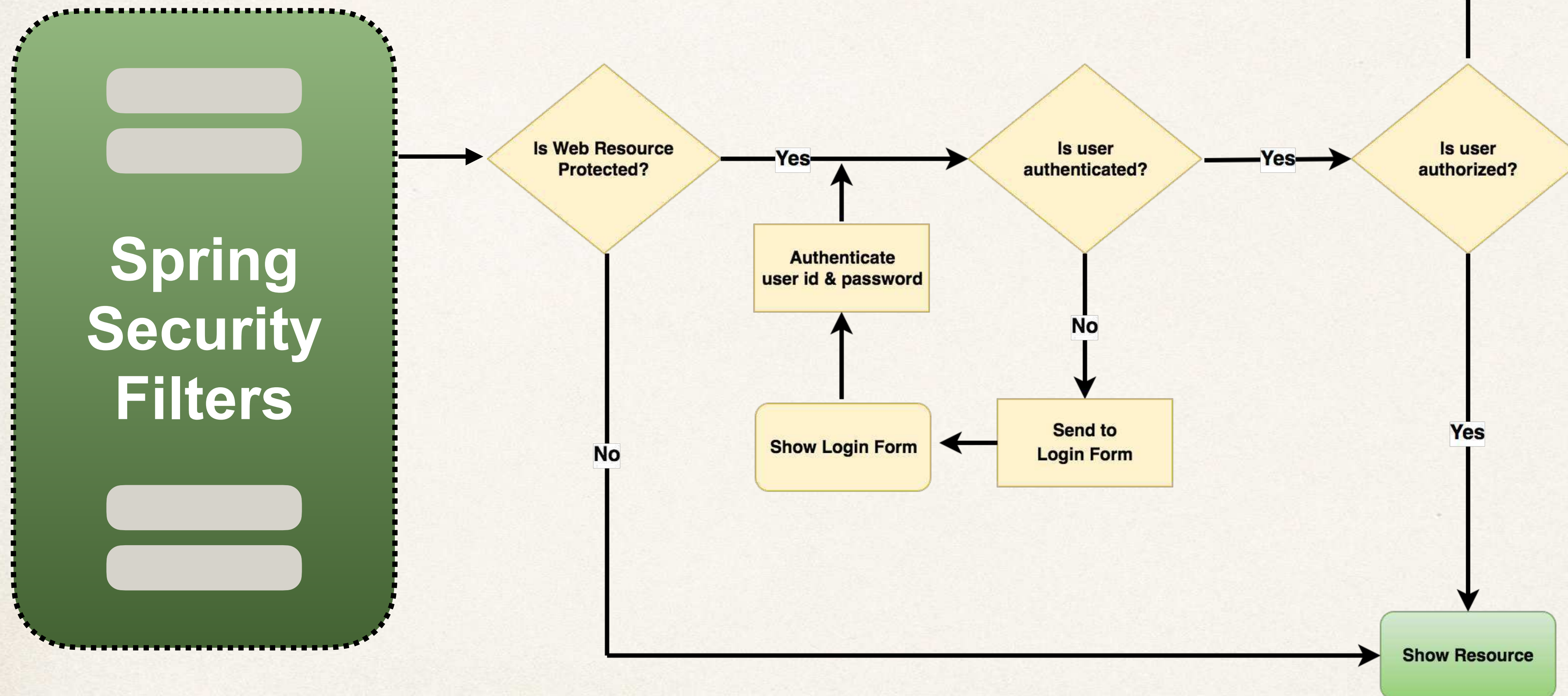
Spring Security with Servlet Filters

- Servlet Filters are used to pre-process / post-process web requests
- Servlet Filters can route web requests based on security logic
- Spring provides a bulk of security functionality with servlet filters

Spring Security Overview

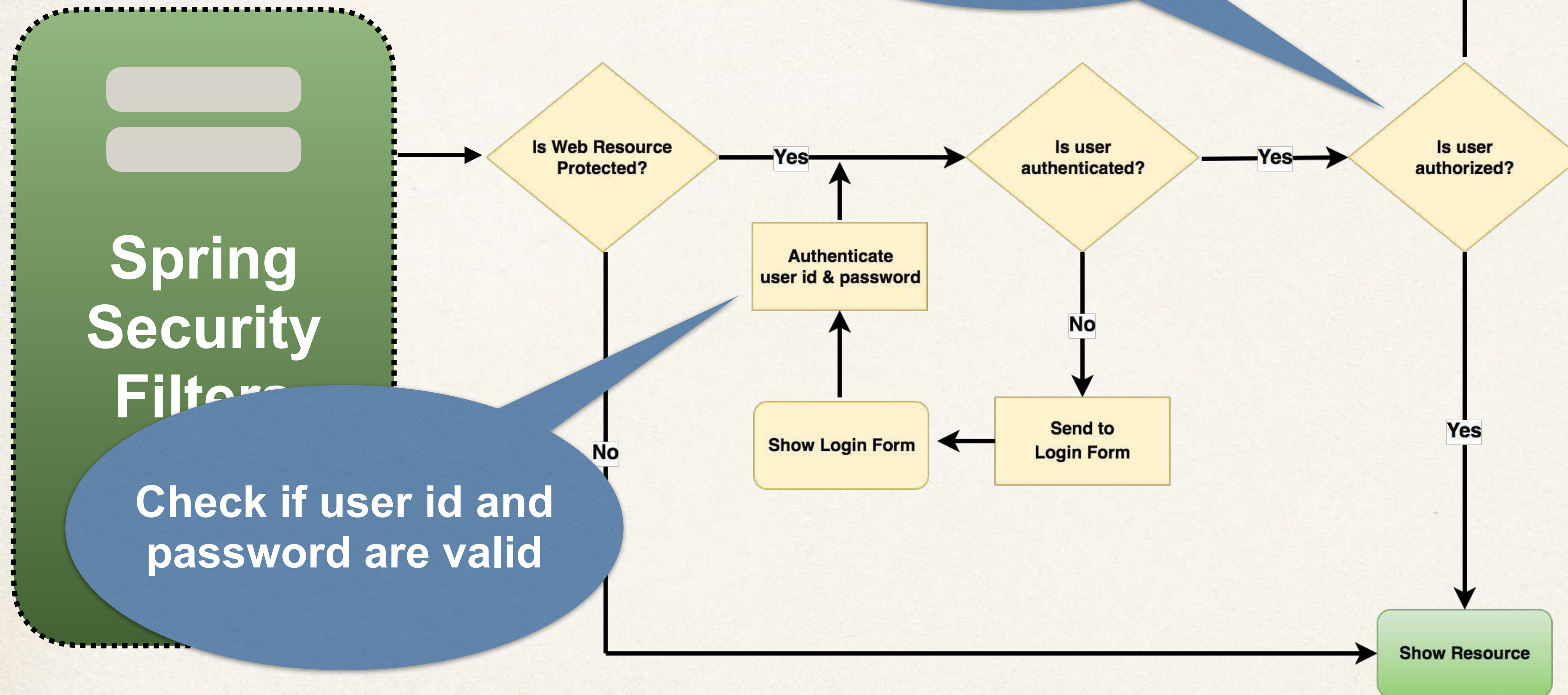


Spring Security in Action



Spring Security in Access

Does user have authorized role?



Security Concepts

- Authentication
 - Check user id and password with credentials stored in app / db
- Authorization
 - Check to see if user has an authorized role

Declarative Security

- Define application's security constraints in configuration
 - All Java config: `@Configuration`
- Provides separation of concerns between application code and security

Programmatic Security

- Spring Security provides an API for custom application coding
- Provides greater customization for specific app requirements

Enabling Spring Security

1. Edit `pom.xml` and add `spring-boot-starter-security`

```
<dependency>  
  <groupId>org.springframework.boot</groupId>  
  <artifactId>spring-boot-starter-security</artifactId>  
</dependency>
```

2. This will *automagically* secure all endpoints for application

Secured Endpoints

- Now when you access your application
- Spring Security will prompt for login

Please sign in

Username

Password

Sign in

Default user name: **user**

Check console logs
for password

```
11-02 21:05:57.074 INFO 24986 --- [main] .s.s.UserDetailsSe  
Using generated security password: 78fd68a6-c190-421d-934b-df7852fc7dc2
```


Spring Security configuration

- You can override default user name and generated password

File: src/main/resources/application.properties

```
spring.security.user.name=scott  
spring.security.user.password=test123
```


Authentication and Authorization

- In-memory
- JDBC
- LDAP
- Custom / Pluggable
- *others ...*



users
passwords
roles

We will cover password storage in DB as plain-text AND encrypted

Configuring Basic Security



Our Users

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE, MANAGER
susan	test123	EMPLOYEE, MANAGER, ADMIN

We can give ANY names
for user roles

Development Process

Step-By-Step

1. Create Spring Security Configuration (@Configuration)
2. Add users, passwords and roles

Step 1: Create Spring Security Configuration

File: DemoSecurityConfig.java

```
import org.springframework.context.annotation.Configuration;

@Configuration
public class DemoSecurityConfig {

    // add our security configurations here ...

}
```


Spring Security Password Storage

- In Spring Security, passwords are stored using a specific format

`{id}encodedPassword`

ID	Description
<code>noop</code>	<code>Plain text passwords</code>
<code>bcrypt</code>	<code>BCrypt password hashing</code>
<code>...</code>	<code>...</code>

Password Example

The encoding
algorithm id

The password

{noop}test123

Let's Spring Security
know the passwords are
stored as plain text (noop)

Step 2: Add users, passwords and roles

File: DemoSecurityConfig.java

```
@Configuration
public class DemoSecurityConfig {

    @Bean
    public InMemoryUserDetailsManager userDetailsManager() {

        UserDetails john = User.builder()
            .username("john")
            .password("{noop}test123")
            .roles("EMPLOYEE")
            .build();

        UserDetails mary = User.builder()
            .username("mary")
            .password("{noop}test123")
            .roles("EMPLOYEE", "MANAGER")
            .build();

        UserDetails susan = User.builder()
            .username("susan")
            .password("{noop}test123")
            .roles("EMPLOYEE", "MANAGER", "ADMIN")
            .build();

        return new InMemoryUserDetailsManager(john, mary, susan);
    }
}
```

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE, MANAGER
susan	test123	EMPLOYEE, MANAGER, ADMIN

We will add DB support in
later videos
(plaintext and encrypted)

Restrict Access Based on Roles



Our Example

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> psert	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> elete employee	ADMIN

Restricting Access to Roles

- General Syntax

Restrict access to a
given path
“/api/employees”

```
requestMatchers(<< add path to match on >>)  
    .hasRole(<< authorized role >>)
```

Single role

“ADMIN”

Restricting Access to Roles

Specify HTTP method:
GET, POST, PUT, DELETE ...

Restrict access to a
given path
“/api/employees”

```
requestMatchers(<< add HTTP METHOD to match on >>, << add path to match on >>)  
    .hasRole(<< authorized roles >>)
```

Single role

Restricting Access to Roles

```
requestMatchers(<< add HTTP METHOD to match on >>, << add path to match on >>)  
    .hasAnyRole(<< list of authorized roles >>)
```

Any role

Comma-delimited list

Authorize Requests for EMPLOYEE role

```
requestMatchers(HttpMethod.GET, "/api/employees").hasRole("EMPLOYEE")
requestMatchers(HttpMethod.GET, "/api/employees/**").hasRole("EMPLOYEE")
```

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> elete employee	ADMIN

The ** syntax:
match on all sub-paths

Authorize Requests for MANAGER role

```
requestMatchers(HttpMethod.POST, "/api/employees").hasRole("MANAGER")
requestMatchers(HttpMethod.PUT, "/api/employees").hasRole("MANAGER")
```

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> ele t e employee	ADMIN

Authorize Requests for ADMIN role

```
requestMatchers(HttpMethod.DELETE, "/api/employees/**").hasRole("ADMIN")
```

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> elete employee	ADMIN

Pull It Together

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE, MANAGER
susan	test123	EMPLOYEE, MANAGER, ADMIN

```
@Bean
public SecurityFilterChain filterChain(HttpSecurity http) throws Exception {

    http.authorizeHttpRequests(configurer ->
        configurer
            .requestMatchers(HttpMethod.GET, "/api/employees").hasRole("EMPLOYEE")
            .requestMatchers(HttpMethod.GET, "/api/employees/**").hasRole("EMPLOYEE")
            .requestMatchers(HttpMethod.POST, "/api/employees").hasRole("MANAGER")
            .requestMatchers(HttpMethod.PUT, "/api/employees").hasRole("MANAGER")
            .requestMatchers(HttpMethod.DELETE, "/api/employees/**").hasRole("ADMIN"));

    // use HTTP Basic authentication
    http.httpBasic(Customizer.withDefaults());

    return http.build();
}
```

Use HTTP Basic Authentication



HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> ele t e employee	ADMIN

Cross-Site Request Forgery (CSRF)

- Spring Security can protect against CSRF attacks
- Embed additional authentication data / token into all HTML forms
- On subsequent requests, web app will verify token before processing
- Primary use case is traditional web applications (HTML forms etc ...)

When to use CSRF Protection?

- The Spring Security team recommends
 - Use CSRF protection for any normal browser web requests
 - Traditional web apps with HTML forms to add / modify data
- If you are building a REST API for non-browser clients
 - you *may* want to disable CSRF protection
- In general, not required for stateless REST APIs
 - That use POST, PUT, DELETE and / or PATCH

Pull It Together

```
@Bean
public SecurityFilterChain filterChain(HttpSecurity http) throws Exception {

    http.authorizeHttpRequests(configurer ->
        configurer
            .requestMatchers(HttpMethod.GET, "/api/employees").hasRole("EMPLOYEE")
            .requestMatchers(HttpMethod.GET, "/api/employees/**").hasRole("EMPLOYEE")
            .requestMatchers(HttpMethod.POST, "/api/employees").hasRole("MANAGER")
            .requestMatchers(HttpMethod.PUT, "/api/employees").hasRole("MANAGER")
            .requestMatchers(HttpMethod.DELETE, "/api/employees/**").hasRole("ADMIN"));

    // use HTTP Basic authentication
    http.httpBasic(Customizer.withDefaults());

    // disable Cross Site Request Forgery (CSRF)
    http.csrf(csrf -> csrf.disable());

    return http.build();
}
```

In general, CSRF is not required for stateless REST APIs that use POST, PUT, DELETE and/or PATCH

403 ERROR - PUT

with Spring Data REST

**This is a non-issue if using code
provided for this lecture
@RestController**

**When using Spring Data REST
for PUT requests the ID is on the URL**

/api/employees/{employeeId}

**As a result, need to modify
the security configuration**

DemoSecurityConfig.java

Replace

.requestMatchers(HttpMethod.PUT, "/api/employees").hasRole("MANAGER")

With

.requestMatchers(HttpMethod.PUT, "/api/employees/").hasRole("MANAGER")**

Note use of /**

**Because the ID is passed on the URL
For PUT requests using Spring Data REST**

Restrict Access Based on Roles

Patch - Partial Updates



Our Example

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
PATCH	/api/employees/{employeeId}	Partial Update	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> elete employee	ADMIN

Authorize Requests for MANAGER role

```
requestMatchers(HttpMethod.PATCH, "/api/employees/**").hasRole("MANAGER")
```

HTTP Method	Endpoint	CRUD Action	Role
GET	/api/employees	<u>R</u> ead all	EMPLOYEE
GET	/api/employees/{employeeId}	<u>R</u> ead single	EMPLOYEE
POST	/api/employees	<u>C</u> reate	MANAGER
PUT	/api/employees	<u>U</u> pdate	MANAGER
PATCH	/api/employees/{employeeId}	Partial Update	MANAGER
DELETE	/api/employees/{employeeId}	<u>D</u> elete employee	ADMIN

The ** syntax:
match on all sub-paths

Spring Security

User Accounts Stored in Database



Database Access

- So far, our user accounts were hard coded in Java source code
- We want to add database access

Advanced

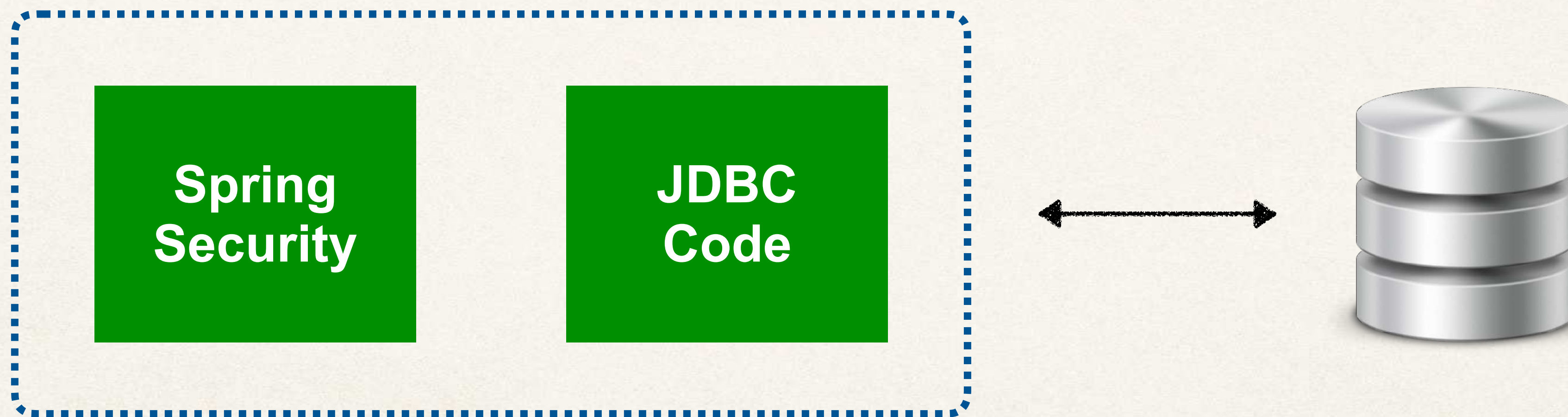
Recall Our User Roles

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE , MANAGER
susan	test123	EMPLOYEE , MANAGER , ADMIN

Database Support in Spring Security

Out-of-the-box

- Spring Security can read user account info from database
- By default, you have to follow Spring Security's predefined table schemas



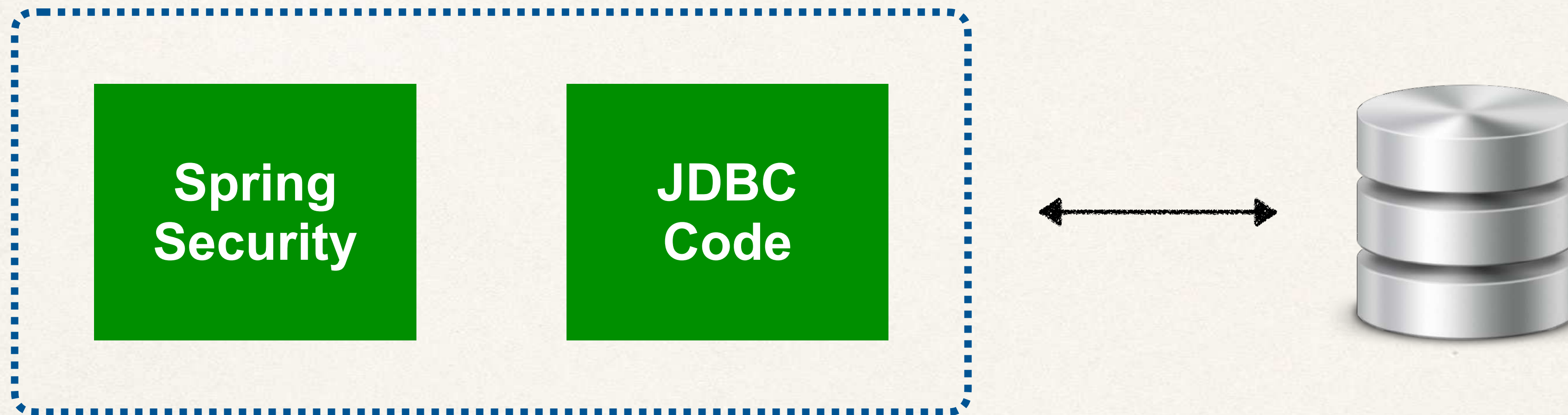
Customize Database Access with Spring Security

- Can also customize the table schemas
- Useful if you have custom tables specific to your project / custom
- You will be responsible for developing the code to access the data
 - JDBC, JPA / Hibernate etc ...

Database Support in Spring Security

Out-of-the-box

- Follow Spring Security's predefined table schemas



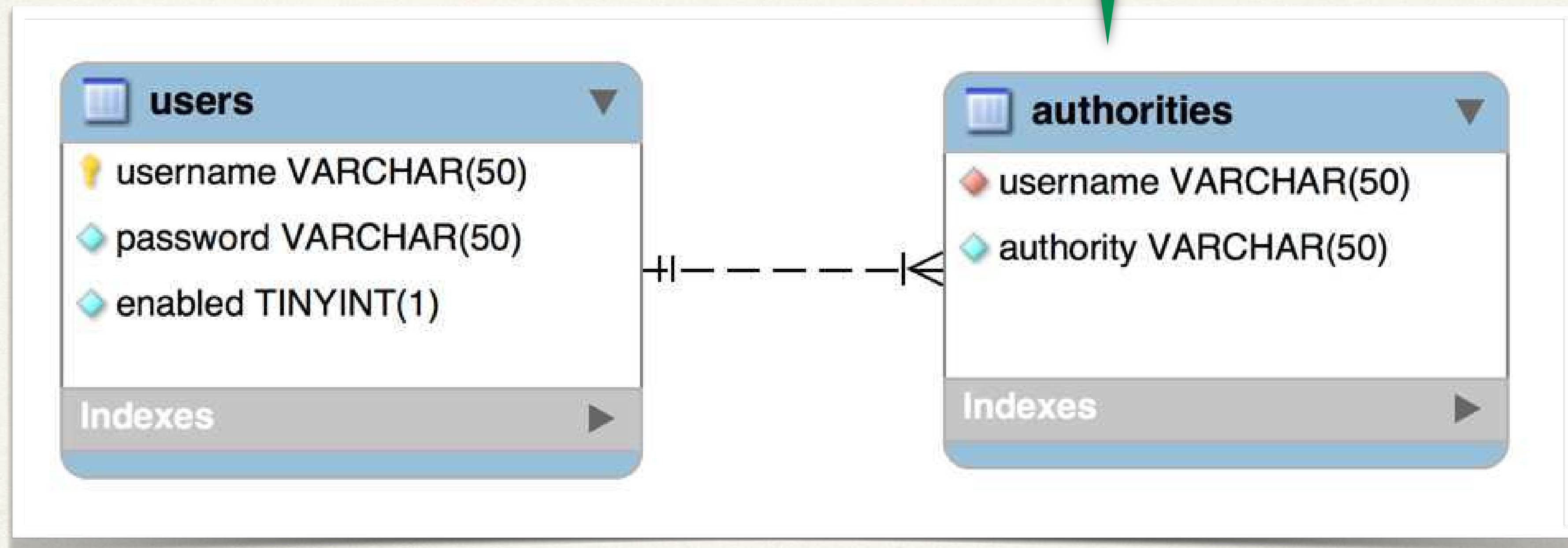
Development Process

Step-By-Step

1. Develop SQL Script to set up database tables
2. Add database support to Maven POM file
3. Create JDBC properties file
4. Update Spring Security Configuration to use JDBC

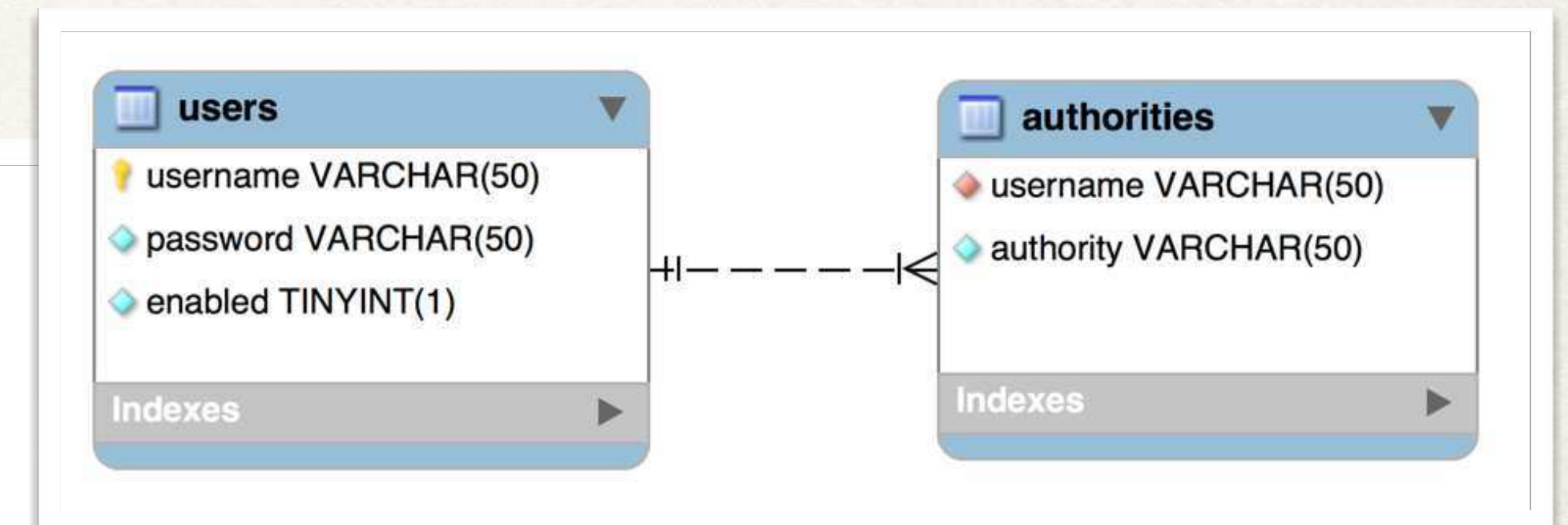
Default Spring Security Database Schema

“authorities” same as “roles”



Step 1: Develop SQL Script to setup database tables

```
CREATE TABLE `users` (  
  `username` varchar(50) NOT NULL,  
  `password` varchar(50) NOT NULL,  
  `enabled` tinyint NOT NULL,  
  
  PRIMARY KEY (`username`)  
  
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```



Step 1: Develop SQL Script to setup database tables

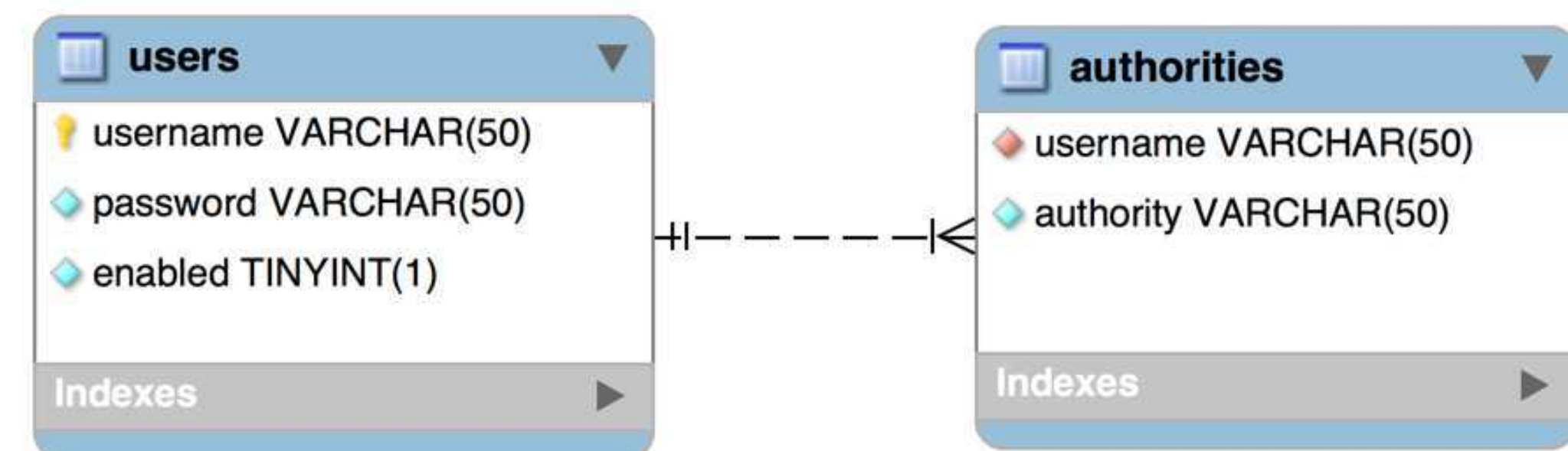
The encoding algorithm id

The password

```
INSERT INTO `users`  
VALUES  
( 'john' , ' {noop}test123' , 1) ,  
( 'mary' , ' {noop}test123' , 1) ,  
( 'susan' , ' {noop}test123' , 1) ;
```

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE, MANAGER
susan	test123	EMPLOYEE, MANAGER, ADMIN

Let's Spring Security know the passwords are stored as plain text (noop)



Step 1: Develop SQL Script to setup database tables

```
CREATE TABLE `authorities` (  
  `username` varchar(50) NOT NULL,  
  `authority` varchar(50) NOT NULL,
```

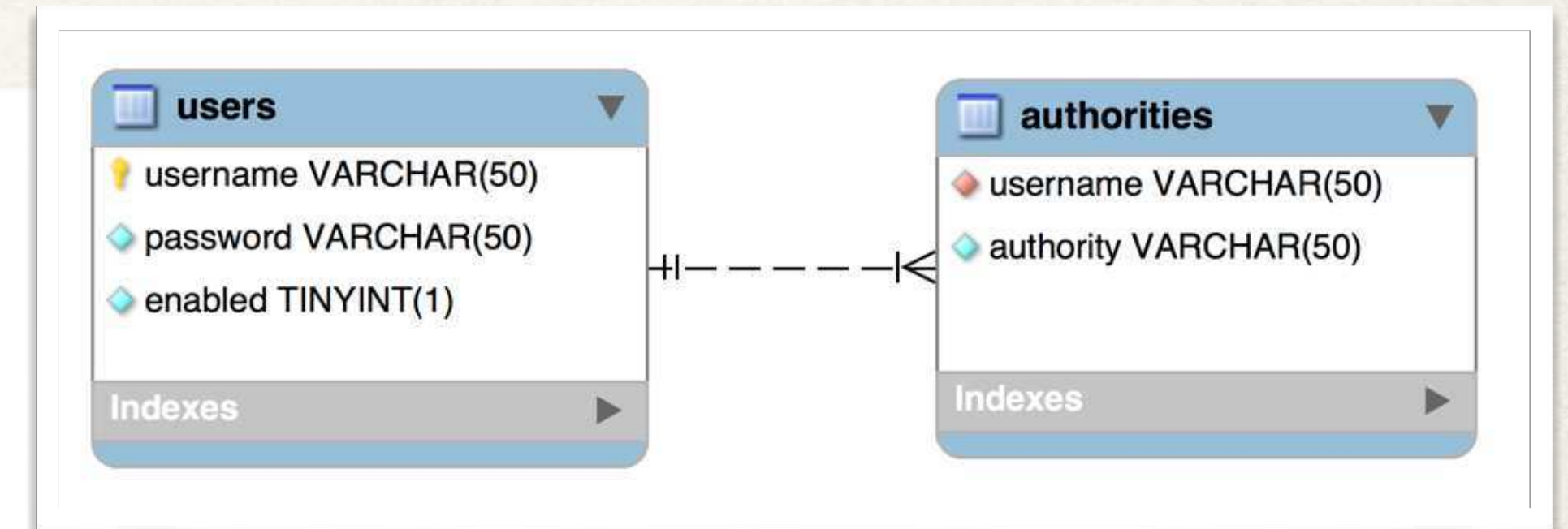
```
  UNIQUE KEY `authorities_idx_1` (`username`,`authority`),
```

```
  CONSTRAINT `authorities_ibfk_1`
```

```
  FOREIGN KEY (`username`)
```

```
  REFERENCES `users` (`username`)
```

```
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```



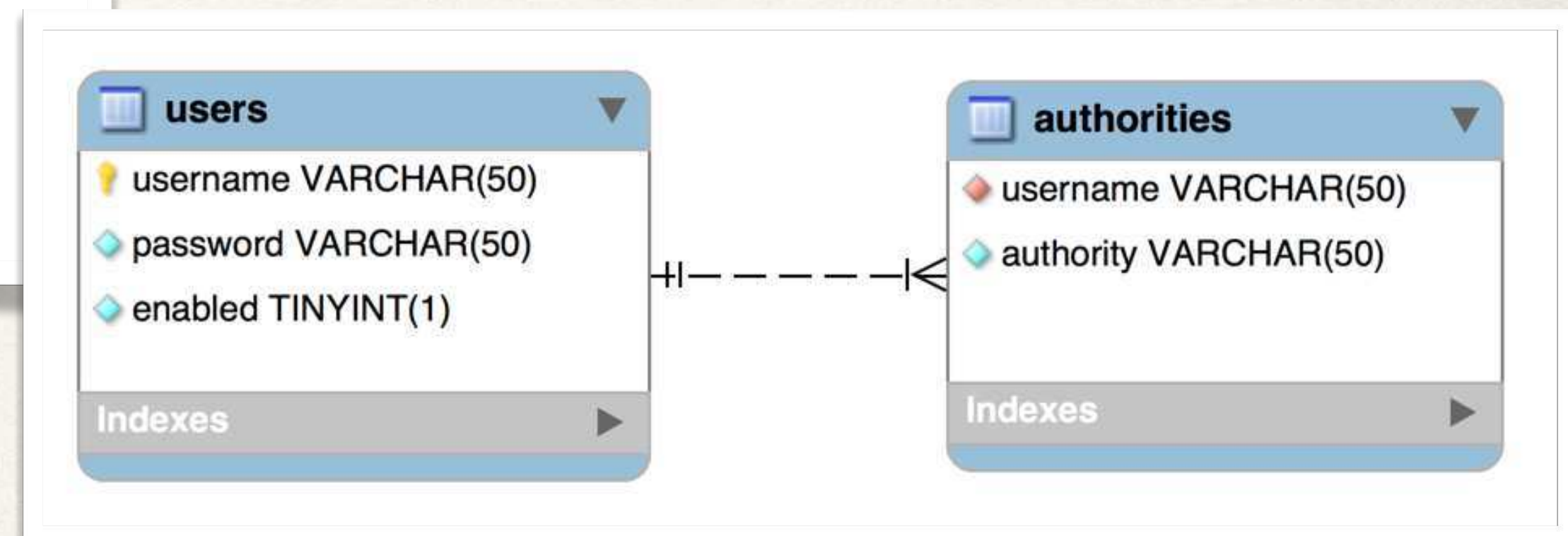
Step 1: Develop SQL Script to setup database tables

“authorities” same as “roles”

```
INSERT INTO `authorities`  
VALUES  
( 'john', 'ROLE_EMPLOYEE' ),  
( 'mary', 'ROLE_EMPLOYEE' ),  
( 'mary', 'ROLE_MANAGER' ),  
( 'susan', 'ROLE_EMPLOYEE' ),  
( 'susan', 'ROLE_MANAGER' ),  
( 'susan', 'ROLE_ADMIN' );
```

Internally Spring Security uses
“ROLE_” prefix

User ID	Password	Roles
john	test123	EMPLOYEE
mary	test123	EMPLOYEE, MANAGER
susan	test123	EMPLOYEE, MANAGER, ADMIN



Step 2: Add Database Support to Maven POM file

```
<!-- MySQL -->  
<dependency>  
  <groupId>com.mysql</groupId>  
  <artifactId>mysql-connector-j</artifactId>  
  <scope>runtime</scope>  
</dependency>
```

JDBC Driver

Step 3: Create JDBC Properties File

File: application.properties

```
#  
# JDBC connection properties  
#  
spring.datasource.url=jdbc:mysql://localhost:3306/employee_directory  
spring.datasource.username=springstudent  
spring.datasource.password=springstudent
```


Step 4: Update Spring Security to use JDBC

Inject data source
Auto-configured by Spring Boot

```
@Configuration
public class DemoSecurityConfig {

    @Bean
    public UserDetailsManager userDetailsManager(DataSource dataSource) {

        return new JdbcUserDetailsManager(dataSource);
    }

    ...
}
```

No longer
hard-coding users :-)

Tell Spring Security to use
JDBC authentication
with our data source

Spring Security Password Encryption



Password Storage

- So far, our user passwords are stored in plaintext ... yikes!

username	password	enabled
john	{noop}test123	1
mary	{noop}test123	1
susan	{noop}test123	1

- Ok for getting started ... but not for production / real-time project :-)

Password Storage - Best Practice

Best Practice

- The best practice is store passwords in an encrypted format

username	password	enabled
john	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1
mary	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1
susan	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1

Encrypted version of password

Spring Security Team Recommendation

- Spring Security recommends using the popular **bcrypt** algorithm
- bcrypt
 - Performs one-way encrypted hashing
 - Adds a random salt to the password for additional protection
 - Includes support to defeat brute force attacks

Bcrypt Additional Information

- Why you should use bcrypt to hash passwords

www.luv2code.com/why-bcrypt

- Detailed bcrypt algorithm analysis

www.luv2code.com/bcrypt-wiki-page

- Password hashing - Best Practices

www.luv2code.com/password-hashing-best-practices

How to Get a Bcrypt password

You have a plaintext password and you want to encrypt using bcrypt

- Option 1: Use a website utility to perform the encryption
- Option 2: Write Java code to perform the encryption

How to Get a Bcrypt password - Website

- Visit: **`www.luv2code.com/generate-bcrypt-password`**
- Enter your plaintext password
- The website will generate a bcrypt password for you

DEMO

Development Process

Step-By-Step

1. Run SQL Script that contains encrypted passwords

- Modify DDL for password field, length should be 68

THAT'S IT ... no need to change Java source code :-)

Spring Security Password Storage

- In Spring Security, passwords are stored using a specific format

`{bcrypt}encodedPassword`

Password column must be at least 68 chars wide

`{bcrypt}` - 8 chars
encodedPassword - 60 chars

username	password	enabled
john	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1
mary	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1
susan	{bcrypt}\$2a\$10\$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQl9YeuspUdgF.q	1

Modify DDL for Password Field

```
CREATE TABLE `users` (  
  `username` varchar(50) NOT NULL,  
  password char(68) NOT NULL,  
  `enabled` tinyint NOT NULL,  
  
  PRIMARY KEY (`username`)  
  
) ENGINE=InnoDB DEFAULT CHARSET=latin1;
```

Password column must be at least 68 chars wide

{bcrypt} - 8 chars

encodedPassword - 60 chars

Step 1: Develop SQL Script to setup database tables

The encoding
algorithm id

The encrypted password: fun123

```
INSERT INTO `users`  
VALUES  
( 'john' , '{bcrypt}$2a$10$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQ19YeuspUdgF.q' , 1) ,  
...
```

Let's Spring Security know the
passwords are stored as
encrypted passwords: bcrypt

Step 1: Develop SQL Script to setup database tables

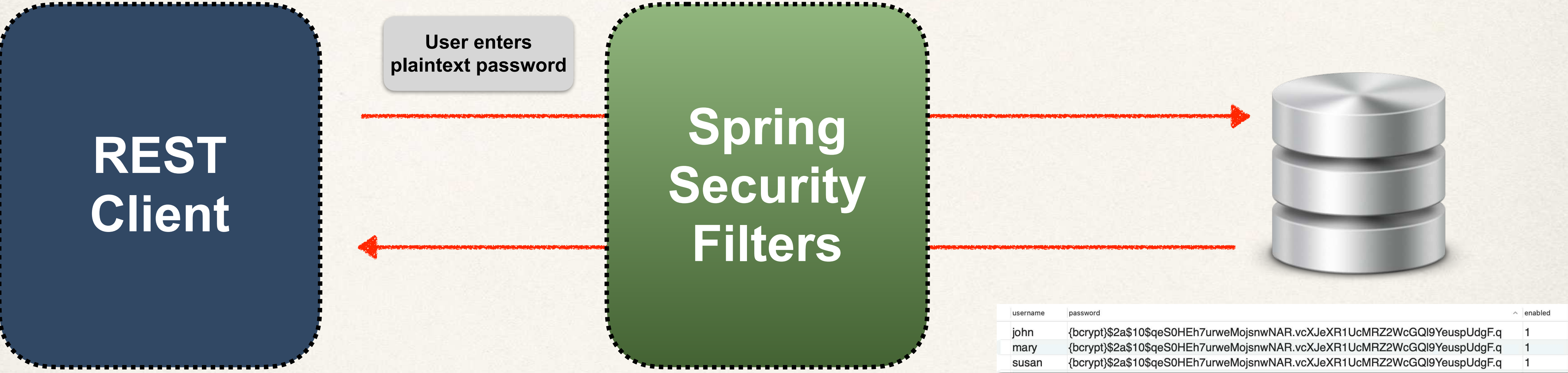
The encoding
algorithm id

The encrypted password: fun123

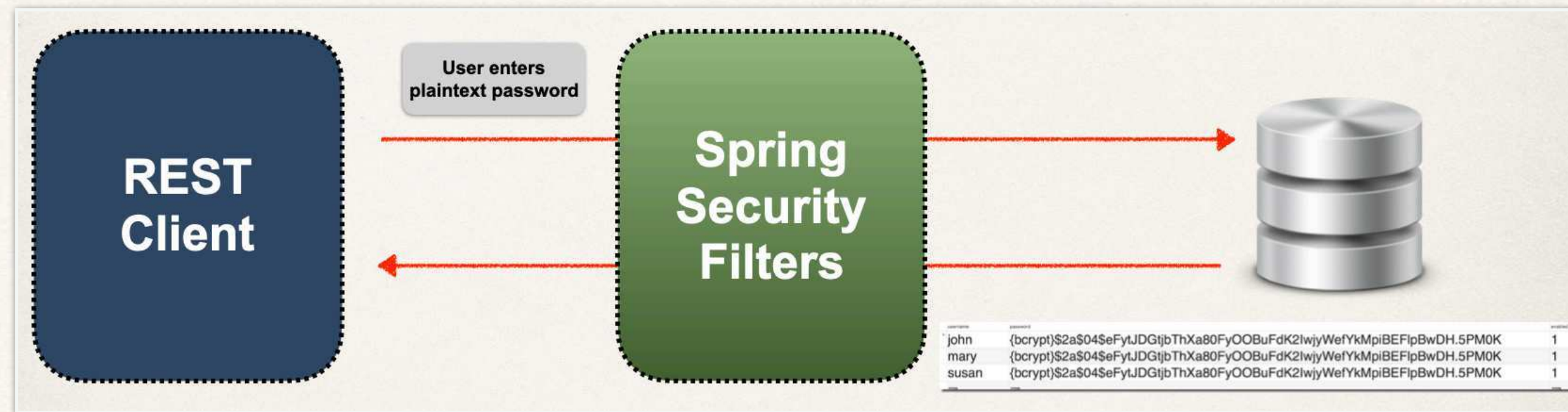
```
INSERT INTO `users`  
VALUES
```

```
( 'john' , '{bcrypt}$2a$10$qeS0HEh7urweMojsnwNAR.vcXJeXR1UcMRZ2WcGQ19YeuspUdgF.q' , 1) ,  
( 'mary' , '{bcrypt}$2a$04$eFytJDGtjbThXa80FyOOBuFdK2IwjyWefYkMpiBEFlpBwDH.5PM0K' , 1) ,  
( 'susan' , '{bcrypt}$2a$04$eFytJDGtjbThXa80FyOOBuFdK2IwjyWefYkMpiBEFlpBwDH.5PM0K' , 1) ;
```


Spring Security Login Process



Spring Security Login Process



Note:
The password from db is
NEVER decrypted

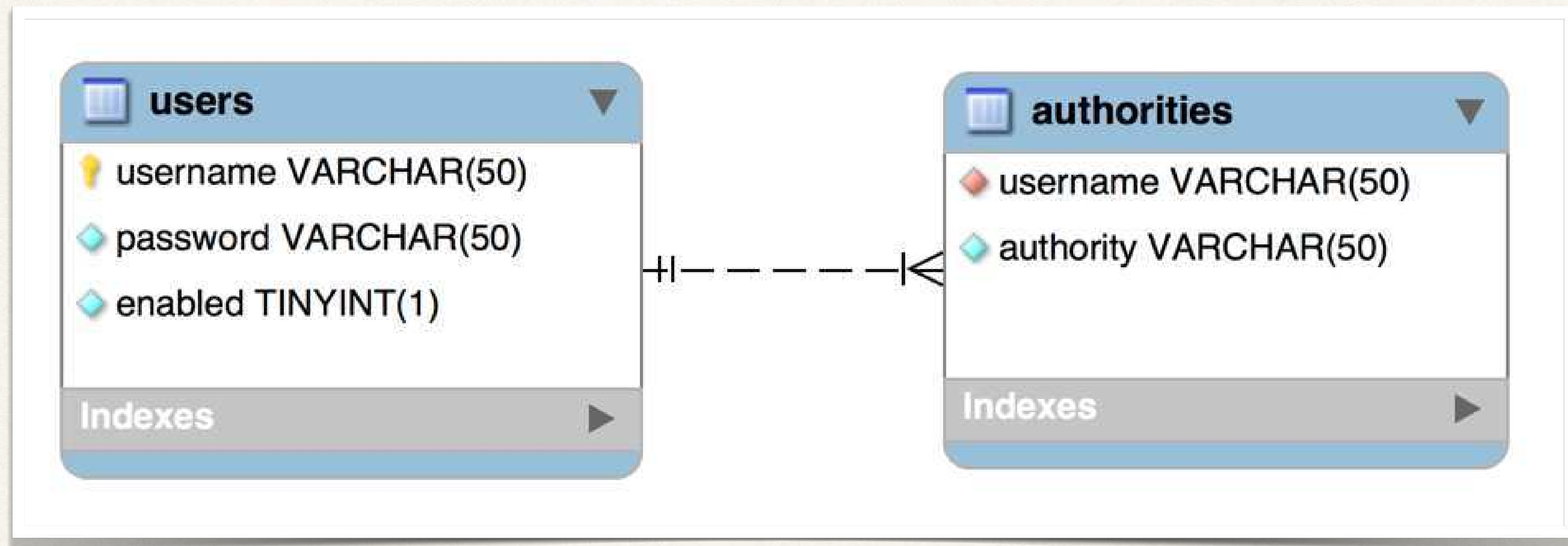
Because bcrypt is a
one-way
encryption algorithm

1. Retrieve password from db for the user
2. Read the encoding algorithm id (bcrypt etc)
3. For case of bcrypt, encrypt plaintext password from login form (using salt from db password)
4. Compare encrypted password from login form **WITH** encrypted password from db
5. If there is a match, login successful
6. If no match, login **NOT** successful

Spring Security Custom Tables

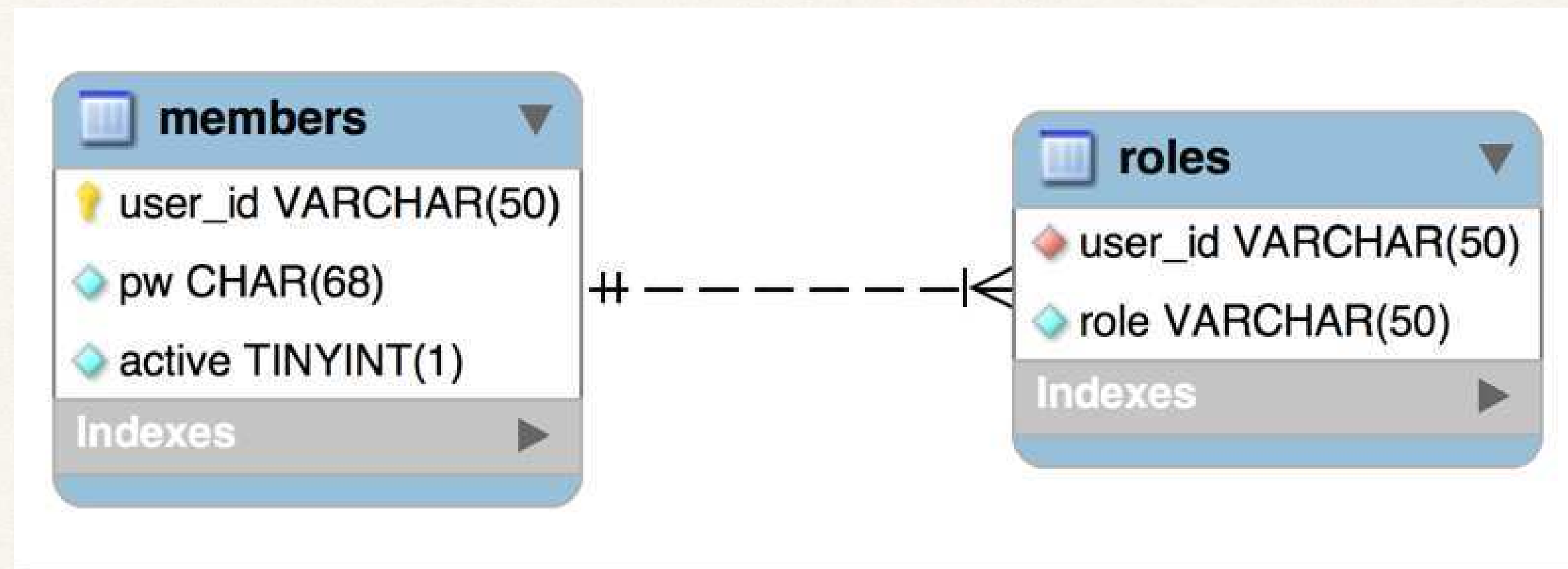


Default Spring Security Database Schema



Custom Tables

- What if we have our own custom tables?
- Our own custom column names?



This is all custom
Nothing matches with default Spring Security table schema

For Security Schema Customization

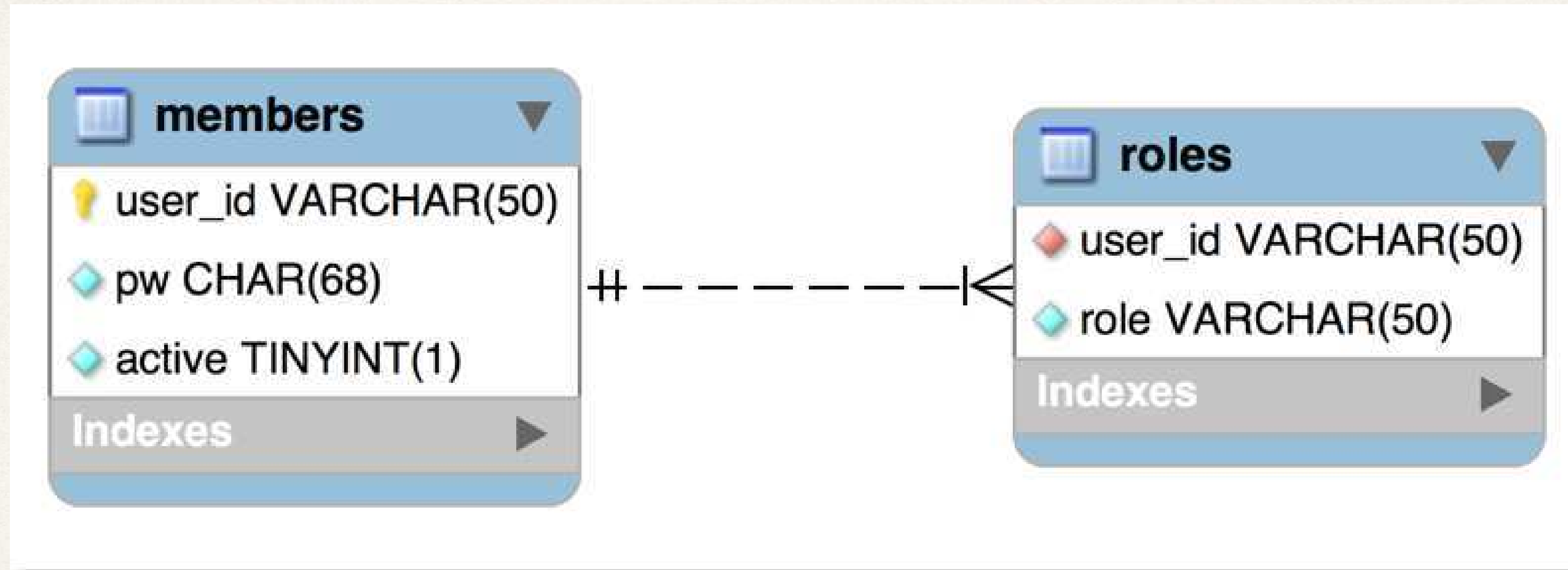
- Tell Spring how to query your custom tables
- Provide query to find user by user name
- Provide query to find authorities / roles by user name

Development Process

Step-By-Step

1. Create our custom tables with SQL
2. Update Spring Security Configuration
 - Provide query to find user by user name
 - Provide query to find authorities / roles by user name

Step 1: Create our custom tables with SQL



This is all custom
Nothing matches with default Spring Security table schema

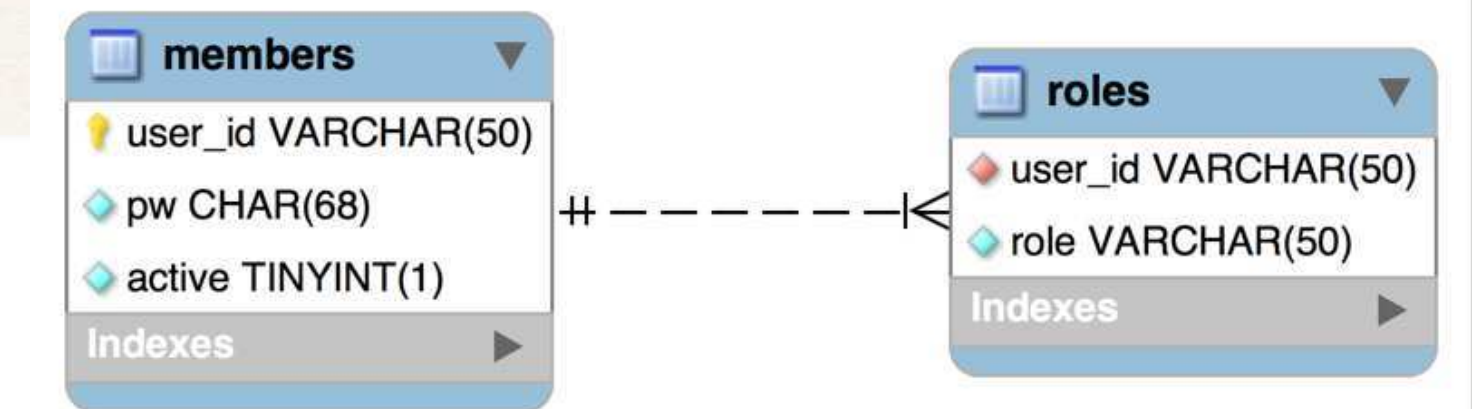
Step 2: Update Spring Security Configuration

@Configuration

```
public class DemoSecurityConfig {
```

@Bean

```
public UserDetailsManager userDetailsManager(DataSource dataSource) {  
    JdbcUserDetailsManager theUserDetailsManager = new JdbcUserDetailsManager(dataSource);  
  
    theUserDetailsManager  
        .setUsersByUsernameQuery("select user_id, pw, active from members where user_id=?");  
  
    theUserDetailsManager  
        .setAuthoritiesByUsernameQuery("select user_id, role from roles where user_id=?");  
  
    return theUserDetailsManager;  
}  
...  
}
```



Step 2: Update Spring Security Configuration

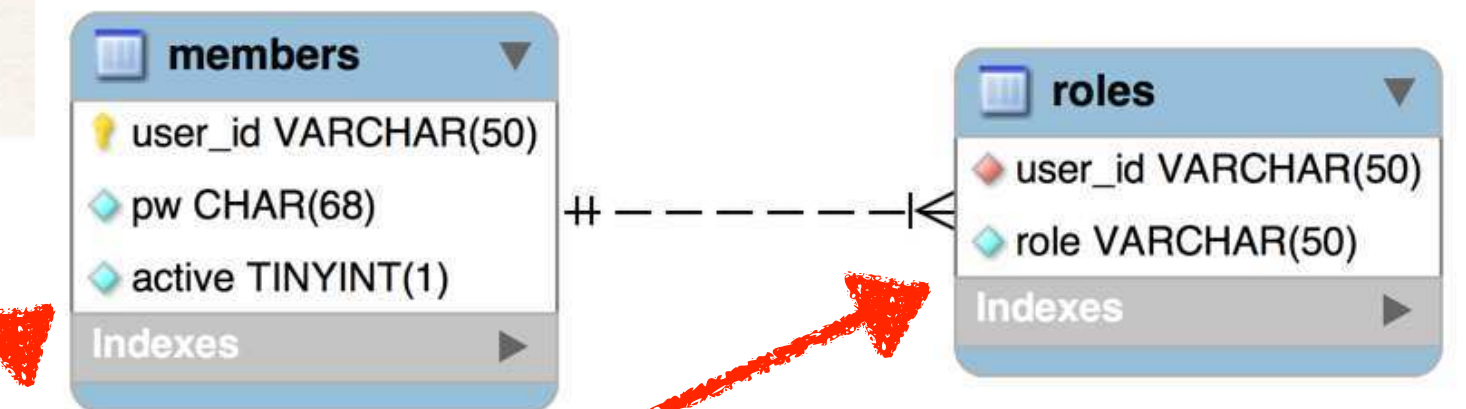
```
@Configuration
public class DemoSecurityConfig {

    @Bean
    public UserDetailsManager userDetailsManager(DataSource dataSource) {
        JdbcUserDetailsManager theUserDetailsManager = new JdbcUserDetailsManager(dataSource);

        theUserDetailsManager
            .setUsersByUsernameQuery("select user_id, pw, active from members where user_id=?");

        theUserDetailsManager
            .setAuthoritiesByUsernameQuery("select user_id, role from roles where user_id=?");

        return theUserDetailsManager;
    }
    ...
}
```



How to find users

How to find roles

Question mark "?"
Parameter value will be the
user name from login